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Equality preference in the claims problem: A questionnaire study of cuts in earnings and pensions

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Equality preference in the claims problem: A questionnaire study of cuts in earnings and pensions

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Abstract

Many distributional conflicts are characterized by the presence of acquired rights. The basic structure of these conflicts is that of the so-called claims problem, in which an amount of money has to be divided among individuals with differing claims and the total amount available falls short of the sum of the claims. We describe the results of a questionnaire in which Belgian and German students were confronted with nine claims problems. In the "Firm" version, respondents had to divide revenue among the owners of a firm who contribute to the activities of the firm in different degrees. In the "Pensions" version, they had to divide tax money among pensioners who have paid different contributions during their active career. Responses in the Pensions version were more egalitarian than in the Firm version. For both versions, the proportional rule performs very well in describing the choices of the respondents. Other prominent rules - in particular the constrained equal awards and constrained equal losses rules - fail to capture some basic intuitions. A substantial part of the respondents tend to become more progressive as the amount to be distributed decreases other things equal, and tend to become more progressive as the inequality in the distribution of claims becomes more unequal other things equal. All of these conclusions are robust with respect to the difference in home-country of the respondents.

Keywords: claims problem, acquired rights, proportional rule, constrained equal awards rule, constrained equal losses rule, inequality

JEL classification: D63

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1 Introduction

Many distributional conflicts in the real world are characterized by the presence of acquired rights. In some cases the legal system has worked out specific rules about how to settle these conflicts: examples are to be found in the sphere of bankruptcy or inheritance legislation. In other cases, however, there is no clear-cut legal solution. Important recent examples of this situation are to be found in the areas of social policy (how to cut social benefits if the budget turns out to be too low to keep all promises?) and of wage policies within a firm (which form of wage moderation is most acceptable when such moderation is made necessary by economic circumstances?). Although the legal status of the acquired rights therefore may differ considerably in different situations, all the problems mentioned before have the same basic theoretical structure. This structure can be described as follows: how ought an amount of money to be distributed among a group of individuals if these individuals have differing acquired rights, i.e., different prior claims with respect to the money, and the amount available for distribution falls short of the sum of these claims?

Psychological feelings of justice and injustice seem to be particularly strong when acquired rights are at stake. Social reactions may then have a considerable impact on the decisions taken and on their economic consequences. Of course, in actual practice, distributional conflicts are settled within a set of well-structured (legal, political, and social) institutions. Moreover, the economic agents involved in the negotiations usually are driven by self-interest and influenced by specific events and promises made in the past. These specific circumstances can only be recovered by detailed empirical research. Yet at the same time, at a more abstract level deeper ethical intuitions may also play a role. These may determine whether specific distributional solutions are in the end acceptable to the parties. They are certainly crucial for the agents that have to arbitrate in these conflicts and that in general have no immediate self-interest in the distributional conflict. It is therefore interesting to investigate the structure of these underlying ethical intuitions.

There is by now a large and rapidly growing social choice literature on this problem—referred to as the "claims problem," the "bankruptcy problem," or the problem of "estate division."[1] In this theoretical literature, each claims problem is completely defined by two characteristics, viz., the vector of claims and the amount to be distributed. The literature then focuses to a large extent on the axiomatic examination of rules, which associate with every claims problem a division of the amount of money among the individuals. Many of the axioms proposed in the literature have ethical content, which implies that the rules they

[1] For overviews of this literature, see Moulin (2002) and Thomson (2003).

characterize are open to interpersonal disagreement. The question thus arises to what degree these various axioms (and therefore the various distribution rules) are found attractive by empirical subjects in solving concrete claims problems. Questionnaire studies may give interesting insights into this question of the empirical acceptance of various ethical theories.[2] The results of these studies are not only relevant from a normative point of view. Investigation of the acceptance of the theoretical axioms may also offer a structured approach to explain why specific decisions are taken in the real-world examples described before.

The theoretical literature makes abstraction from the particular economic context in which the problem is situated. Knowledge of the basic characteristics of the problem, i.e., the vector of claims and the amount to be distributed, is sufficient to determine the solution. Unambigouous adherence to a rule implies that it is consistently applied to all claims problems. This is a strong requirement, as it might be possible that the acceptance of the ethical axioms is to some degree dependent on the level of the respective claims or on the amount to be distributed. Moreover, if rules are to be applied in practice, then the particular economic context is likely to be important as well, as it influences the ethical status of the characteristics of the claims problem. Therefore, from an empirical perspective, the following two questions appear to be of importance. (i) *Within-context consistency:* for a given economic context, to what degree do people use the same rule for different claims problems, i.e., claims problems with different claims vectors and/or available money amounts? (ii) *Between-context uniformity:* for a given claims problem, to what degree do people propose the same division for different economic contexts?

Previous questionnaire studies on claims problems—such as Schokkaert and Overlaet (1989), Béhue (2003), and Herrero, Moreno-Ternero, and Ponti (2006) —have mainly focused on the question of between-context uniformity. The available results consistently show that the answers of respondents depend on the economic context of the problem. Until now, within-context consistency has received only modest attention. To analyse within-context consistency, one has to go further than overall means and consider the complete choice patterns of individual respondents over several claims problems.

In this paper, we deal with both the question of within-context consistency and that of between-context uniformity. The former question is tackled by consideration of a wide variety of claims problems, which are all presented to each respondent, and by giving special attention to individual level data. The question of between-context uniformity is dealt with by using two versions of the questionnaire with the same claims problems—in the Firm version, three firm

[2]There is an increasing interest in economics in the empirical study of the acceptance of theories of distributive justice. See Konow (2003) and Schokkaert (1999) for recent overviews.

owners have to distribute a loss, and in the Pensions version, a shortage in funds has to be distributed over three pensioners. We tried to formulate socially relevant problems, so that our results may contribute to understanding real-world issues. Moreover, we tried to avoid situations in which there is a well-defined legal solution to the distributional conflict, as this might have influenced strongly the answers of the respondents. In the discussion of the results, we will focus especially on the question of how respondents vary tolerance for inequality under variations of the characteristics of the claims problem and of the economic context. We organized the survey in two different countries, Belgium and Germany, in both cases using student samples. A priori one would not expect large differences in the attitudes of Belgian and German students: our results therefore offer a test of the robustness of the methodology.

The paper is structured as follows. In Section 2 we present several rules and introduce our conceptualization of tolerance for inequality. Section 3 discusses the setup of our questionnaire. In Section 4, the results of the questionnaire are presented and discussed. Section 5 concludes.

2 Theoretical background

A claims problem involves the division of an amount $E \in \mathbb{R}_+$ among the individuals in a set $N = \{1,2,\ldots,n\}$ who have claims adding up to more than E. The *claims vector* is a vector $(c_1,c_2,\ldots,c_n) \in \mathbb{R}^n_+$ where, for all $i \in N$, c_i denotes individual i's *claim*. Formally, a *claims problem* is an ordered pair $(c,E) \in \mathbb{R}^n_+ \times \mathbb{R}_+$ for which $c_1 + c_2 + \cdots + c_n \geq E$. The set $\mathscr{C}$ collects all claims problems.

The literature on claims problems focuses on rules, which select for each claims problem a division of the amount available between the individuals. Formally, a *rule* is a function R that associates with each $(c,E) \in \mathscr{C}$ an element of $\mathbb{R}^n_+$, referred to as an *awards vector*, under the conditions $R_1(c,E) + R_2(c,E) + \cdots + R_n(c,E) = E$, and $0 \leq R_i(c,E) \leq c_i$ for all $i \in N$. In line with the literature, we accept these two conditions as part of the description of the problem. Note, however, that they have real ethical content and are not necessarily innocuous when analysing opinions.

One of the objectives in the discussion of our questionnaire results will be to study how well various rules for solving claims problems explain the choices of the respondents.[3] The three most prominent rules are the proportional, constrained equal awards, and constrained equal losses rules.[4]

The proportional rule makes awards proportional to claims.

[3] For a thorough discussion of all the rules considered in this paper, see Thomson (2003).

[4] These rules are called the "three musketeers" by Herrero and Villar (2001).

Proportional rule (*P*). *For all* $(c,E) \in \mathscr{C}$*, we have* $P(c,E) = \lambda c$ *where* λ *solves* $\sum_{i \in N} \lambda c_i = E$.

Note that if $c_1 + c_2 + \cdots + c_n > 0$, then each individual receives a proportion $E/(c_1 + c_2 + \cdots + c_n)$ of her claim.

The constrained equal awards rule equalizes awards under the constraint that no individual receives an award that exceeds her claim.

Constrained equal awards rule (*CEA*). *For all* $(c,E) \in \mathscr{C}$ *and all* $i \in N$*, we have* $CEA_i(c,E) = \min\{c_i, \lambda\}$ *where* λ *solves* $\sum_{i \in N} \min\{c_i, \lambda\} = E$.

The constrained equal losses rule equalizes losses—an individual's loss is defined as the difference between her claim and award—under the constraint that no individual receives a negative award.

Constrained equal losses rule (*CEL*). *For all* $(c,E) \in \mathscr{C}$ *and all* $i \in N$*, we have* $CEL_i(c,E) = \max\{0, c_i - \lambda\}$ *where* λ *solves* $\sum_{i \in N} \max\{0, c_i - \lambda\} = E$.

The five remaining rules considered in the discussion of the questionnaire results are: the Talmud (*T*), Piniles' (*Pin*), constrained egalitarian (*CE*), random arrival (*RA*), and minimal overlap (*MO*) rules. These rules are defined formally in Appendix A. As an illustration of the differences between the eight rules in solving concrete claims problems, see Tables 3 to 11, which present the solutions proposed by the various rules for the nine claims problems used in our questionnaire.

In the literature several of these eight rules have been characterized in terms of formal axioms. It is surprising, however, how little attention is paid to the overall pattern of the ensuing distributions of awards. Yet the eight rules do imply different attitudes to inequality, an aspect that may play an important role in the opinions of lay observers. It certainly is crucial in discussions about acquired rights in the real world. We shall pay special attention to this feature in discussing our results. In order to make inequality comparisons, we define the concept standardly used in the literature on inequality measurement, viz., the Lorenz dominance relation.[5] Let $x, y \in \mathbb{R}^n_+$ be two arbitrary vectors such that $x_1 \leq x_2 \leq \cdots \leq x_n$ and $y_1 \leq y_2 \leq \cdots \leq y_n$. Then, x is said to *Lorenz dominate* y if, for all $k = 1, 2, \ldots, n-1$,

$$\frac{x_1 + x_2 + \cdots + x_k}{x_1 + x_2 + \cdots + x_n} \geq \frac{y_1 + y_2 + \cdots + y_k}{y_1 + y_2 + \cdots + y_n}.$$

We say that x *strictly* Lorenz dominates y if, in addition, at least one of these inequalities holds strictly. Of two awards vectors proposed for the same claims

[5] See Cowell (2000) and Lambert (2001) for recent overviews of this literature.

problem, one is referred to as less unequal than the other if it Lorenz dominates the other. The rule that proposes the less unequal awards vector, will be referred to as *more progressive* for the given claims problem than the one that proposes the more unequal awards vector. The general Lorenz dominance relationships between the rules are described in Bosmans and Lauwers (2007).[6]

The three prominent rules constitute benchmark cases with respect to progressivity: they imply a uniform attitude in terms of progressivity irrespective of the specific characteristics of the claims problem at hand. The proportional rule is neutral with respect to progressivity in the sense that it chooses from the available awards vectors the (only) one which is Lorenz equivalent to the claims vector. The constrained equal awards and constrained equal losses rules both are extreme cases. Roughly speaking, the former always selects the least unequal awards vector available for any rule, while the latter always selects the most unequal one available for any rule.[7]

In contrast to the three prominent rules, the behaviour of the other five rules with respect to progressivity is not so clear-cut. As the solutions of the various rules for the claims problems in Tables 3 to 11 show, it is not the case that these rules behave in the same way with regard to progressivity for all claims problems. For instance, Piniles' rule and the constrained egalitarian rule propose the constrained equal awards division for some claims problems and the proportional division for others. The same is true for the Talmud, random arrival, and minimal overlap rules, which, in addition, propose the constrained equal losses division for certain claims problems.

3 The setup of the questionnaire

In the questionnaire, respondents were asked to state their preferred awards vector for nine different claims problems, which are presented in Table 1. Each of the nine claims problems is a combination of one of three possible claims vectors and one of three possible amounts to divide. The three possible claims vectors have the same sum of claims, but differ in terms of inequality (in the Lorenz sense). We mention the claims vectors in order of increasing inequality: $(1500, 2000, 2500)$, $(1000, 2000, 3000)$, and $(500, 2000, 3500)$. The three possible amounts to divide,

[6] See Hougaard and Thorlund-Petersen (2001) and Moreno-Ternero and Villar (2006) for related results.

[7] More precisely, the constrained equal awards rule always selects the least unequal awards vector available for any rule satisfying order preservation of awards (for all $(c,E) \in \mathscr{C}$ and all $i, j \in N$, if $c_i \leq c_j$, then $R_i(c,E) \leq R_j(c,E)$), while the latter always selects the most unequal one available for any rule satisfying order preservation of awards and order preservation of losses (for all $(c,E) \in \mathscr{C}$ and all $i, j \in N$, if $c_i \leq c_j$, then $c_i - R_i(c,E) \leq c_j - R_j(c,E)$). This result is well known in the literature. For a proof, see Bosmans and Lauwers (2007).

Table 1. The questions, all amounts in euros

Question 1	c = (1500, 2000, 2500)	E = 4500
Question 2	c = (1500, 2000, 2500)	E = 3000
Question 3	c = (1500, 2000, 2500)	E = 1500
Question 4	c = (1000, 2000, 3000)	E = 4500
Question 5	c = (1000, 2000, 3000)	E = 3000
Question 6	c = (1000, 2000, 3000)	E = 1500
Question 7	c = (500, 2000, 3500)	E = 4500
Question 8	c = (500, 2000, 3500)	E = 3000
Question 9	c = (500, 2000, 3500)	E = 1500

4500, 3000, and 1500, are greater than, equal to, and smaller than the sum of the half-claims, respectively.[8] By using all nine combinations of these claims vectors and amounts to divide in our questionnaire, we obtain data for a wide variety of claims problems. The questionnaire design allows us to analyse the effect on responses of a change in the amount to divide for a given claims vector (questions 1, 2, and 3; questions 4, 5, and 6; questions 7, 8, and 9), as well as the effect of a change in claims inequality for a given amount to divide (questions 1, 4, and 7; questions 2, 5, and 8; questions 3, 6, and 9). For each of the nine questions, respondents were presented with a list of alternative awards vectors to choose from. These lists of awards vectors are given in Tables 3 to 11—we emphasize that the information in the first two columns of these tables (pertaining to which rules are consistent with each of the awards vectors) was not presented to the respondents. To be able to examine *within-context consistency*, i.e., the degree to which respondents use the same rule for different claims problems, the awards vectors selected by each of the rules defined in the previous section are included in the lists of alternatives for every question.

In order to allow us to tackle the question of *between-context uniformity*, i.e., the question of how the economic context in which the claims problems are presented affects responses, we consider two versions of the questionnaire with the same nine claims problems, but with different background stories. Each respondent gets only one version of the questionnaire. The questions in the "Firm" version are formulated as follows (here we consider question 1):

> Persons A, B, and C own a firm together. A, B, and C contribute to the activities of the firm in different degrees, and for this reason they have agreed that their salaries differ. They receive monthly €1,500, €2,000, and €2,500, respectively. Each of the three persons has also

[8] As is made clear in Appendix A, the sum of the half-claims is an important benchmark in the definition of the Talmud, Piniles', and constrained egalitarian rules. It is also an important benchmark in comparing the progressivity of the various rules (see Bosmans and Lauwers, 2007).

other sources of income. Due to an unexpected deterioration of the economic circumstances, the part of the revenue of the firm that can be used for salaries in a certain month amounts to only €4,500, not enough to compensate the three firm directors. What is in your view the most just distribution of the sum of €4,500 among persons A, B, and C?

In the "Pensions" version, the questions were formulated as follows (here we again consider question 1):

> Persons A, B, and C go on retirement. On the basis of the contributions they have paid during their active career, they are entitled to a monthly pension of €1,500, €2,000, and €2,500, respectively. Due to the demographic ageing, these pension amounts can no longer be paid. The government only has €4,500 monthly to spend on the pensions of A, B, and C. What is in your view the most just distribution of the sum of €4,500 among persons A, B, and C?

The two versions of the questionnaire differ, explicitly or implicitly, in several respects. First, the status of the differences between the claims of the three individuals is different. In the Firm version, these differences are agreed upon by the three firm owners, while in the Pensions version they are explained by contributions in the past of the three pensioners and hence by wage differences during the active career. Therefore, in the Firm version respondents are likely to interpret the differences between claims to be caused more by desert and less by talent than in the Pensions version. Second, the two versions of the questionnaire differ with respect to the relation between the claims or awards and the ultimate outcomes relevant to the three individuals. In the Firm version it is specified that the individuals have also other sources of income. In the Pensions version on the other hand, it is likely that respondents view the pension amounts as very important, perhaps even the only, sources of income of the three individuals. Finally, the scope of the decision is different in the two versions of the questionnaire. Whereas in the Firm version awards pertain only to one monthly pay, in the Pensions version payments are implied to be determined by the decision for much longer.

Questions were presented in series of three: with the long introductions given above for the first of the three questions and shorter introductions for the second and third. After each series of three questions, respondents were encouraged to provide written comments on their choices. The questionnaire was anonymous. In order to test for order effects, we used several variants of the questionnaire with different orders of the questions and different orders of the alternatives. There

Table 2. Sample sizes

	Belgium	Germany	All
Firm	123	153	276
Pensions	118	154	272

were no significant differences between these alternative variants, and we therefore pooled all the data.

The questionnaire was conducted among the first year undergraduate economics and business students of the Catholic University of Leuven, Belgium, in May 2005, and among graduate economics and business students of the University of Osnabrück, Germany, in November 2005. None of the students had already been exposed to the theory of claims problems in their study programs. In the course of one week, the questionnaires were filled in by the students at the start of several exercise sessions. In each session, roughly half of the students participated in the Firm version of the questionnaire, and the other half in the Pensions version. The sample sizes are given in Table 2.

4 Results

4.1 A first look

Tables 3 to 11 report the percentages of the respondents who chose each of the alternative awards vectors in questions 1 to 9, respectively. Results are given for the Belgian (B) and German (G) samples separately, as well as for the pooled sample (All). The awards vectors presented to the respondents appear in sequence of increasing inequality (in the sense of the Lorenz criterion). Recall that the constrained equal awards rule always selects the least unequal awards vector, while the constrained equal losses rule selects the most unequal one. For convenience of exposition, we have distinguished three sets of alternatives in the tables. First, the *neutral* awards vector is the one consistent with the proportional rule—it is referred to as neutral because it is Lorenz equivalent to the claims vector. Second, the awards vectors that Lorenz dominate the neutral solution are referred to as *egalitarian*. Third, the *anti-egalitarian* awards vectors are the ones that are Lorenz dominated by the neutral solution. The tables also report which rules are consistent with each of the alternative awards vectors.

The results appear to be very similar for Belgium and Germany. The chi-square tests in the first nine rows of Table 12 test for each question separately the null hypothesis that the population proportions for the categories egalitarian, neutral, and anti-egalitarian, respectively, are equal for Belgium and Germany. The test in the last row does the same for the complete set of questions, i.e., for 27

Table 3. Question 1, $c = (1500, 2000, 2500)$ and $E = 4500$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA, CE*	(1500, 1500, 1500)		4	5	4	4	2	3
	Pin	(1250, 1500, 1750)		12	14	13	21	16	18
			Total	*16*	*19*	*17*	*25*	*18*	*21*
Neutr.:	*P*	(1125, 1500, 1875)		55	43	49	46	40	43
Anti-egal.:		(1050, 1500, 1950)		2	2	2	7	5	6
	CEL, T, RA, MO	(1000, 1500, 2000)		27	34	31	22	34	29
			Total	*29*	*36*	*33*	*29*	*39*	*35*

Table 4. Question 2, $c = (1500, 2000, 2500)$ and $E = 3000$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA*	(1000, 1000, 1000)		2	5	4	5	5	5
		(850, 1000, 1150)		14	7	10	22	13	17
			Total	*16*	*12*	*14*	*27*	*18*	*22*
Neutr.:	*P, T, CE, Pin, RA*	(750, 1000, 1250)		58	56	57	47	56	52
Anti-egal.:		(650, 1000, 1350)		7	7	7	12	9	10
	CEL, MO	(500, 1000, 1500)		20	24	22	14	16	15
			Total	*27*	*31*	*29*	*26*	*25*	*25*

Table 5. Question 3, $c = (1500, 2000, 2500)$ and $E = 1500$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA, T, CE, Pin, RA, MO*	(500, 500, 500)		9	5	7	11	16	14
		(450, 500, 550)		9	9	9	24	14	18
			Total	*18*	*14*	*16*	*36*	*30*	*32*
Neutr.:	*P*	(375, 500, 625)		59	50	54	44	42	43
Anti-egal.:		(250, 500, 750)		21	27	24	16	24	20
	CEL	(0, 500, 1000)		3	7	5	3	3	3
			Total	*24*	*34*	*29*	*19*	*27*	*23*

Table 6. Question 4, $c = (1000, 2000, 3000)$ and $E = 4500$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA, CE*	(1000, 1750, 1750)		1	2	2	0	1	0
	Pin	(1000, 1500, 2000)		11	13	12	17	16	17
			Total	*12*	*15*	*14*	*17*	*17*	*17*
Neutr.:	*P*	(750, 1500, 2250)		73	58	65	64	64	64
Anti-egal.:	*RA*	(666, 1416, 2416)		4	4	4	5	6	6
	CEL, T, MO	(500, 1500, 2500)		11	20	16	14	12	13
			Total	*15*	*24*	*20*	*19*	*18*	*19*

Table 7. Question 5, $c = (1000, 2000, 3000)$ and $E = 3000$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA*	(1000, 1000, 1000)		2	1	1	3	3	3
		(700, 1000, 1300)		14	10	12	24	19	21
			Total	*16*	*11*	*13*	*27*	*22*	*24*
Neutr.:	*P, T, CE, Pin, RA*	(500, 1000, 1500)		73	72	73	61	69	66
Anti-egal.:	*MO*	(333, 833, 1833)		9	8	8	9	6	7
	CEL	(0, 1000, 2000)		2	6	4	3	1	2
			Total	*11*	*14*	*12*	*12*	*7*	*9*

Table 8. Question 6, $c = (1000, 2000, 3000)$ and $E = 1500$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA, T, CE, Pin*	(500, 500, 500)		11	5	8	14	19	17
	MO, RA	(333, 583, 583)		4	2	3	17	9	12
			Total	*15*	*7*	*11*	*31*	*28*	*29*
Neutr.:	*P*	(250, 500, 750)		70	70	70	58	53	55
Anti-egal.:		(150, 500, 850)		12	14	13	8	11	9
	CEL	(0, 250, 1250)		3	5	4	2	2	2
			Total	*15*	*19*	*17*	*10*	*13*	*11*

Table 9. Question 7, $c = (500, 2000, 3500)$ and $E = 4500$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA, CE*	(500, 2000, 2000)		3	3	3	5	4	4
	Pin	(500, 1625, 2375)		10	7	8	18	25	22
		(450, 1600, 2450)		2	4	3	12	10	11
		(400, 1500, 2600)		12	11	11	13	9	10
			Total	*27*	*25*	*25*	*48*	*48*	*47*
Neutr.:	*P*	(375, 1500, 2625)		48	47	48	34	29	31
Anti-egal.:	*RA*	(333, 1333, 2833)		3	6	5	7	6	6
	T	(250, 1375, 2875)		12	9	10	6	7	6
	MO	(166, 1416, 2916)		7	5	6	2	5	3
	CEL	(0, 1500, 3000)		4	5	4	2	3	2
			Total	*26*	*25*	*25*	*17*	*21*	*17*

Table 10. Question 8, $c = (500, 2000, 3500)$ and $E = 3000$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA*	(500, 1250, 1250)		6	4	5	17	12	14
		(350, 1100, 1550)		13	8	10	30	23	26
			Total	*19*	*12*	*15*	*47*	*35*	*40*
Neutr.:	*P, T, CE, Pin, RA*	(250, 1000, 1750)		67	72	70	44	43	44
Anti-egal.:	*MO*	(166, 916, 1916)		9	7	8	4	7	6
	CEL	(0, 750, 2250)		3	5	4	2	1	2
			Total	*12*	*12*	*12*	*6*	*8*	*8*

Table 11. Question 9, $c = (500, 2000, 3500)$ and $E = 1500$

				Firm			Pensions		
	Rule(s)	Awards vector		B	G	All	B	G	All
Egal.:	*CEA*	(500, 500, 500)		4	3	4	17	17	17
	T, CE, Pin	(250, 625, 625)		6	3	4	16	8	12
	MO, RA	(166, 666, 666)		5	0	2	3	3	3
			Total	*15*	*6*	*10*	*36*	*28*	*32*
Neutr.:	*P*	(125, 500, 875)		62	64	63	46	42	43
Anti-egal.:		(100, 450, 950)		9	12	11	6	9	7
		(50, 450, 1000)		8	9	9	3	9	6
	CEL	(0, 0, 1500)		4	4	4	3	3	3
			Total	*21*	*25*	*24*	*12*	*21*	*16*

Table 12. Homogeneity of Belgian and German results, p-values for χ^2 tests

Question	Firm	Pensions
1	0.187	0.116
2	0.463	0.150
3	0.113	0.407
4	0.064	0.981
5	0.464	0.267
6	0.148	0.637
7	0.995	0.609
8	0.294	0.432
9	0.061	0.076
All questions	0.350	0.726

Table 13. Homogeneity of firm and pensions versions, p-values for χ^2 tests

Question	Belgium	Germany	All
1	0.172	0.810	0.308
2	0.095	0.252	0.047
3	0.010	0.003	0.000
4	0.287	0.304	0.417
5	0.074	0.011	0.002
6	0.007	0.000	0.000
7	0.002	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
All questions	0.000	0.000	0.000

(3×9) categories. The evidence clearly supports the null hypothesis. Therefore, we will discuss the pooled data in this subsection. Given the small differences in the characteristics of the Belgian and German samples, significant differences between the results would have been rather worrying. The support for the null hypothesis is a reassuring indication that our questionnaire method leads to robust findings.

We first focus on the question of between-context uniformity, i.e., on the differences between the results obtained with the two versions of the questionnaire. *Overall, the evidence suggests that responses are less egalitarian in the Firm version than in the Pensions version.* In all nine questions, the percentage of the respondents that chose egalitarian awards vectors is lower in the Firm version than in the Pensions version, and in eight out of nine questions the percentage that chose anti-egalitarian awards vectors is higher in the Firm version than in the Pensions version. The first nine rows of Table 13 test for each question separately the null hypothesis that the population proportions for the categories egalitarian, neutral, and anti-egalitarian, respectively, are equal for the two questionnaire ver-

sions, and the last row does the same for the complete set of questions. Table 13 confirms that responses are significantly different for the two versions. The evidence that respondents chose less egalitarian alternatives in the Firm version than in the Pensions version is particularly strong in the case of questions 3, 6, 7, 8, and 9. Note that in each of these questions the majority of the alternative award vectors feature incomes lower than €500, an amount close to the minimally guaranteed income in Belgium and Germany. The fact that respondents in the Pensions version are especially egalitarian in these cases, suggests that they may have some concern for a minimum level of income being respected—in fact, this concern was expressed explicitly by several respondents in the comments box of the questionnaire. Put differently, for low awards, considerations with respect to needs appear to override considerations with respect to claims. It is interesting to note that the evidence suggests that the reason why respondents choose more egalitarian alternatives in the Pensions version is not because they favour equality in itself, but rather because they want to make sure individuals get a sufficient amount of income. We will return to the interpretation of these results in a later section.

The aggregate data given in Tables 3 to 11 is not suitable for examining within-context consistency, i.e., for evaluating the degree to which rules are successful in describing the choices of the respondents. It is inherent in the definition of a rule that it proposes an awards vector for *every* claims problem. Hence, to evaluate the acceptance of a given rule, we need to look at the entire response patterns of individual respondents, not just at overall mean responses. However, one first impression on the basis of the aggregate data is worth mentioning. *The awards vectors consistent with the proportional rule perform very well in explaining responses: they are convincingly most popular in every question.* Although this is true for both versions of the questionnaire, it is even more outspoken in the Firm version than in the Pensions version. Note that, both for the Firm version and for the Pensions version, the proportional rule is especially popular in questions 4, 5, and 6 where the claims vector is $(1000, 2000, 3000)$. It is hard to find an economic explanation for this observation—perhaps it is simply due to the fact that, for the given claims vector, the awards vectors of the proportional rule are particularly easy to calculate.

In the next subsection, we will provide a more robust analysis based on individual level data to compare the empirical performance of the various rules. Before moving on, however, we discuss two basic intuitions of the respondents that are revealed in the aggregate data for both versions of the questionnaire: concerns for *strict order preservation* and *nonzero awards*. Both of these concerns were also stated explicitly in comments by several respondents.

Respondents in both questionnaire versions seem to want the order in claims to be preserved strictly in awards. Alternatives in which individuals with dif-

Table 14. Percentages of consistency with rules

	Firm			Pensions		
Rule	B	G	All	B	G	All
P	38	33	36	20	19	19
CEA	0	0	0	0	0	0
CEL	2	3	2	2	1	1
T	0	0	0	0	0	0
Pin	0	0	0	0	0	0
CE	0	0	0	0	0	0
RA	0	0	0	0	0	0
MO	0	0	0	0	0	0

ferent claims get the same award only appear in the sets of egalitarian awards vectors of the questions. For all questions in which alternatives are available in the set of egalitarian awards vectors that respect strict order preservation (this is the case in all questions except 6 and 9), the awards vector that violates strict order preservation is least popular among the egalitarian awards vectors for both questionnaire versions. Since the constrained equal awards rule never respects strict order preservation for the claims problems in our questionnaire, its awards vectors perform rather badly in describing respondents' choices.

There seems to be a reluctance among respondents in both questionnaire versions to give an individual a zero award. Awards vectors in which an individual gets a zero award only appear as the least egalitarian alternative in the set of anti-egalitarian awards vectors of the questions. In all questions in which such an alternative is present (all questions except 1, 2, and 4), it is least popular among the anti-egalitarian awards vectors for both versions of the questionnaire. This is particularly relevant to explain the limited success of the constrained equal losses rule, which always selects the awards vector with zero awards in these cases. At the same time, in the questions in which the constrained equal losses rule gives everyone strictly more than zero (questions 1, 2, and 4), its awards vectors are most popular in the set of anti-egalitarian solutions.

4.2 A comparison of rules

Strictly speaking, a respondent is consistent with a rule only if she chooses the awards vectors implied by the rule in all questions. Due to the relatively high number of questions in the questionnaire, this test is rather demanding however. *Nevertheless, as Table 14 shows, substantial numbers of respondents were consistent with the proportional rule in all nine questions for both questionnaire versions.* Given this good performance, it is not surprising that respondents often mentioned in their comments that they were applying a proportional procedure

Table 15. Percentages of lowest distances to award vectors of rules

		Firm			Pensions		
	Rule	B	G	All	B	G	All
Egalitarian:	*CEA*	2	1	2	4	3	4
	CE	1	1	1	0	0	0
	Pin	6	5	5	23	16	19
Neutral or ambiguous:	*P*	75	68	71	58	55	56
	T	2	5	4	2	2	2
	RA	6	12	9	5	20	14
	MO	6	5	5	6	3	4
Anti-egalitarian:	*CEL*	2	5	4	3	1	2

throughout the questionnaire. The only other rule that respondents have chosen consistently with in all nine questions is the constrained equal losses rule: however, this is the case only for very low numbers of respondents in each of the two versions of the questionnaire. Our finding concerning the dominating position of the proportional rule is in line with the questionnaire results of Gächter and Riedl (2006) and Herrero, Moreno-Ternero, and Ponti (2006).

A less demanding method for comparing the performance of the various rules in describing respondents' choices can be obtained using the following concept of "distance." Let (c^ℓ, E^ℓ) be the claims problem used in question $\ell = 1, 2, \ldots, 9$ and denote the awards vector chosen by respondent k in question ℓ by $A^k(c^\ell, E^\ell)$. We define the "distance" between the set of awards vectors chosen by k and the set of awards vectors for rule R as $\sum_{\ell=1}^{9} \sum_{i=1}^{3} |A_i^k(c^\ell, E^\ell) - R_i(c^\ell, E^\ell)|$, i.e., as the total money amount that respondent k deviates from what is prescribed by rule R. The calculated distances can be used to compare the empirical performance of the different rules: the lower the distance, the better the performance of the rule in describing the choices of the given respondent.

Table 15 presents, for each rule, the percentages of the respondents for whom the rule is ranked first, i.e., for whom the distance to the given rule is lower than that to each other rule. The categories *egalitarian*, *anti-egalitarian*, and *neutral* are defined similarly as in Tables 3 to 11. A rule is categorized as *ambiguous* if it does not belong to any of the three other categories for all questions. *For the Firm version, the proportional rule clearly performs best. Of the other rules, the random arrival rule stands out somewhat in the German sample, but not in the Belgian sample. For the Pensions version, the proportional rule also comes out first, but less overwhelmingly so: Piniles' rule and, in the German sample, the random arrival rule also perform well.* It is remarkable that Piniles' rule and the random arrival rule outperform the prominent constrained equal awards and constrained equal losses rules. As suggested before, this may be linked to the

Table 16. Evolution of progressivity as the amount to divide decreases

Belgium								
			Same				Decrease-	Increase-
Quest.	Context	*P*	*CEA*	*CEL*	Decrease	Increase	Increase	Decrease
1, 2, 3	Firm	45	2	2	3 (0.998)	22 (0.000)	9 (0.923)	4 (1.000)
	Pensions	29	2	2	9 (0.872)	26 (0.000)	6 (1.000)	3 (1.000)
4, 5, 6	Firm	55	0	2	8 (0.471)	16 (0.000)	2 (1.000)	7 (0.962)
	Pensions	39	0	2	6 (0.978)	21 (0.000)	2 (1.000)	5 (1.000)
7, 8, 9	Firm	43	1	2	11 (0.106)	10 (0.179)	2 (1.000)	10 (0.952)
	Pensions	25	3	2	7 (0.881)	15 (0.025)	4 (1.000)	11 (0.990)
Germany								
			Same				Decrease-	Increase-
Quest.	Context	*P*	*CEA*	*CEL*	Decrease	Increase	Increase	Decrease
1, 2, 3	Firm	37	2	4	7 (0.929)	25 (0.000)	5 (1.000)	7 (0.999)
	Pensions	26	1	3	7 (0.996)	34 (0.000)	7 (1.000)	6 (1.000)
4, 5, 6	Firm	48	0	5	10 (0.289)	14 (0.012)	1 (1.000)	5 (1.000)
	Pensions	36	0	1	8 (0.890)	24 (0.000)	3 (1.000)	7 (0.999)
7, 8, 9	Firm	40	0	3	17 (0.000)	11 (0.114)	2 (1.000)	9 (0.989)
	Pensions	20	1	1	10 (0.546)	15 (0.047)	1 (1.000)	10 (1.000)

concern for strict order preservation and to the reluctance to award zero amounts. Table 15 also confirms the conclusion with respect to the differences between the two questionnaire versions that was stated in the previous subsection: egalitarian rules do better in the Pensions version.

4.3 Variations in degree of egalitarianism

In the previous subsection, we studied the question of within-context consistency, i.e., whether respondents use the same rule for each claims problem. Here, we consider a similar question but in terms of progressivity. We examine whether respondents take, for each claims problem, the same position with respect to progressivity, or whether they vary their position in a straightforward manner depending on the characteristics of the claims problem at hand. Specifically, we analyse whether there is a meaningful pattern to be found under two basic variations of the claims problem: (a) a decrease of the amount to divide while the claims remain the same, and (b) an increase in the inequality of the claims vector while the amount to divide remains the same.

In Table 16, the response patterns over the combinations of questions relevant for question (a) are summarized (in percentages). The category *same* covers the response patterns consistent with the proportional rule, the constrained equal awards rule, or the constrained equal losses rule, i.e., the patterns in which the de-

gree of progressivity remains unchanged. The other four categories—*decrease*, *increase*, *decrease-increase*, and *increase-decrease*—describe simple variations in progressivity, and are also defined using the three prominent rules as benchmark cases. To give an example: a response pattern over questions 1, 2, and 3 which is consistent with the constrained equal awards rule in question 1, consistent with the proportional rule in question 2 and consistent with the constrained equal losses rule in question 3, would be categorized under *decrease*.[9] A complete description of the response patterns belonging to each of the categories is given in Appendix B. The conclusions of this subsection are qualitatively the same for the Belgian and German samples: because, as a consequence, the results for the pooled sample do not provide additional insights, we do not give these in the tables.

The category *same* performs best empirically, a result that can be ascribed to the popularity of the proportional rule. It is more interesting to examine how well the various other categories perform in describing the choices of those respondents not consistent with the *same* category. Therefore, Table 16 provides p-values for the null hypothesis that the population proportion for each of the given categories is equal to what it would be if choices of respondents not consistent with the *same* category were completely random.[10] *We find that, for both versions of the questionnaire, the category* increase*, describing an increase in progressivity as the amount to divide decreases, performs well empirically, whereas all other categories fail.* The popularity of the *increase* category is consistent with the observation made in Subsection 4.1 that respondents seem to attribute importance to minimal income needs. What is interesting is that this pattern appears to be present not only for the Pensions version of the questionnaire, but also for the Firm version, albeit in a somewhat weaker form.

Table 17 presents similar results as Table 16 but for question (b), i.e., for an increase in the inequality of the claims vector while keeping the amount to divide constant. As before, the *same* consistent patterns perform very well. The question again arises how the other categories perform in describing the choices

[9]The reason why the Lorenz dominance relation was not used to define the categories, is that this relation is not appropriate for making progressivity comparisons between awards vectors proposed for *different* claims problems. To illustrate this point, suppose a respondent chooses the awards vectors consistent with the constrained equal awards rule in both questions 4 and 5. The Lorenz dominance relation would in that case say that the respondent is less progressive in question 4 than in question 5, while it seems more natural to conclude instead that the respondent takes the same position with respect to progressivity in the two questions, viz., the extremely egalitarian one. The problem with the Lorenz dominance relation is that it does not take into account the restrictions standardly imposed in the literature on claims problems—in the case of the illustration, it fails to recognize that an individual should never receive an award greater than her claim.

[10]The p-values are for the one sided exact test based on the binomial distribution.

Table 17. Evolution of progressivity as claims inequality increases

Belgium								
Quest.	Context	*P*	Same *CEA*	*CEL*	Decrease	Increase	Decrease-Increase	Increase-Decrease
1, 4, 7	Firm	42	0	2	11 (0.242)	22 (0.000)	8 (0.988)	7 (0.998)
	Pensions	21	0	2	8 (0.908)	34 (0.000)	13 (0.983)	3 (1.000)
2, 5, 8	Firm	49	2	2	3 (0.996)	17 (0.001)	2 (1.000)	7 (0.966)
	Pensions	30	1	2	3 (1.000)	26 (0.000)	9 (0.994)	2 (1.000)
3, 6, 9	Firm	48	4	2	11 (0.106)	8 (0.414)	2 (1.000)	7 (0.957)
	Pensions	34	8	2	5 (0.972)	18 (0.002)	5 (1.000)	3 (1.000)
Germany								
Quest.	Context	*P*	Same *CEA*	*CEL*	Decrease	Increase	Decrease-Increase	Increase-Decrease
1, 4, 7	Firm	35	1	4	4 (0.997)	26 (0.000)	6 (1.000)	7 (1.000)
	Pensions	21	0	1	5 (0.998)	32 (0.000)	10 (0.999)	7 (1.000)
2, 5, 8	Firm	48	0	5	7 (0.856)	20 (0.000)	2 (1.000)	4 (1.000)
	Pensions	30	1	1	3 (1.000)	25 (0.000)	7 (1.000)	6 (1.000)
3, 6, 9	Firm	42	2	4	9 (0.512)	11 (0.125)	3 (1.000)	9 (0.946)
	Pensions	26	12	2	10 (0.428)	14 (0.037)	1 (1.000)	8 (0.996)

of the respondents who are not consistent with this category. *The table shows that, for both the Firm version and the Pensions version, the* increase *category, describing an increase in progressivity as claims inequality increases, performs very well empirically, whereas all other categories fail.*[11] A similar pattern was found by Gächter and Riedl (2006) on the basis of results for two questions. The good performance of the increase category may again be seen as an indication of the importance of minimal income needs: as claims inequality increases, the claim of the individual with the lowest claim decreases, so that an increase in progressivity is required in order to ensure a minimal amount for the individual in question.

The pattern of increasing progressivity in the cases of decreasing amount to divide or increasing claims inequality is striking. It seems worthwhile to work out the theoretical consequences of this idea.

[11] Note that the *increase* category is less popular for the combination of questions 3, 6, and 9. In the Pensions version, however, the popularity of the constrained equal awards rule (in the *same* category) for this combination is remarkable. Since the constrained equal awards rule is the most progressive rule possible, its good performance is to the disadvantage of the *increase* category.

4.4 Acquired rights and cuts in earnings and pension benefits

It is of course impossible to draw strong policy conclusions from the answers on highly stylized questions that abstract completely from possibly crucial institutional features. On the other hand, this abstract setting may make it possible to discover deeper ethical intuitions. Let us therefore cautiously formulate some general conclusions on real-world issues that we can draw from our questionnaire results.

In the first place, our results confirm that feelings about being treated in a fair way may play a crucial role in the psychological acceptability of different distributions. One may indeed hypothesize that both the requirement that the order in claims is preserved strictly in the awards and the requirement that no individual should get a zero award, express deep psychological feelings about a minimum level of respect for acquired rights. Note that in our setting these concerns were expressed (implicitly) by observers that are not themselves directly involved in the distributional conflict.

In the second place, the dominating position of the proportional rule is striking and is certainly in line with everyday practice. It turns out, however, that the popularity of more progressive rules increases if the distribution problem gets more "difficult," in that either the amount to divide decreases or the inequality in the initial claims increases. In general, this suggests that an overall perspective on inequality plays a role in the evaluation of different solutions. More particularly, our findings may express a specific concern for the weakest groups, even in the firm setting where the claims are closely linked to productive contributions and have been agreed upon by the parties concerned.

In the third place, mainly in the pensions problem, we recover the popularity of the idea of a "minimum floor" in the distribution. This idea is described by Elster (1992) as an integral part of the commonsense conception of justice. It came also out strongly in the experiments of Frohlich and Oppenheimer (1992). At the same time, however, even in the pensions case responses were dominated by the proportional rule. Our respondents overall do not express a strongly egalitarian view on pensions. Perhaps we should not exaggerate the importance of this finding. It may be caused by the general setting of the questionnaire, by which the attention of the respondents was directed towards differences in contributions and not, e.g., towards differences in needs. It may also be influenced by the fact that both our samples come from countries with a traditionally Bismarckian type of pension system, where benefits are indeed linked to contributions. More research is needed to distinguish these different interpretations.[12]

[12]It could also be interesting to explore the links between the answers on stylized ("ethical") questions, such as the ones analysed in this paper, and the more institutionally rooted questions, as exemplified in Boeri, Börsch-Supan, and Tabellini (2001, 2002).

5 Conclusion

We discussed in this paper the results of a questionnaire study concerning claims problems that was held among Belgian and German students. The results are remarkably robust over the two samples. Two versions of the questionnaire were considered—the Firm version and the Pensions version—in which the same claims problems were presented in different economic contexts. The questionnaire setup allowed us to consider (i) the question of within-context consistency, i.e., the degree to which respondents apply the same rule for different claims problems in the same economic context, and (ii) the question of between-context uniformity, i.e., the degree to which respondents propose the same awards vector for the same claims problem in different economic contexts.

To start with the latter question: responses were clearly more egalitarian in the Pensions version of the questionnaire than in the Firm version. We suggested that this phenomenon could be due to the fact that the given context induced respondents to give more weight to respect for basic needs in the choice of awards vectors. The finding that the distributions chosen in different claims problems are dependent on the economic context of the problem is not new. From a theoretical point of view, it raises the difficult challenge of the construction of a kind of meta-theory that would give a formal structure to the relationship between the characteristics of the economic environment and the choice of a specific rule. Considerations of personal responsibility and differential needs will certainly play an important role here.

With regard to the question of within-context consistency, we found that the proportional rule performed very well in describing the choices of the respondents in both versions of the questionnaire. The other two rules that play a prominent role in the literature, viz., the constrained equal awards and constrained equal losses rules, fail to capture basic intuitions of the respondents. The constrained equal awards rule in many cases gives equal awards to individuals with different claims, whereas respondents seemed to prefer to respect these differences in the choice of the awards vector. Respondents also appeared to be reluctant to give a zero award to an individual with a nonzero claim, an intuition typically violated by the constrained equal losses rule. Both intuitions are largely neglected in the theoretical literature.[13]

We also considered the question of within-context consistency from the inequality perspective. The questionnaire design allowed us to examine variations in the tolerance of inequality of the respondents under simple changes of the characteristics of the claims problem. We found that, for those respondents who did not adopt a uniform attitude towards inequality in all claims problems, response

[13]However, since recently the imposition of lower bounds on awards is studied. See, among others, Moreno-Ternero and Villar (2004) and Dominguez and Thomson (2006).

patterns describing an increase in progressivity as the amount to divide decreases other things equal and as inequality of the claims vector increases other things equal performed well empirically. Here also, the questionnaire results suggest interesting opportunities for further theoretical work. Indeed, while simple ideas stated in terms of inequality are useful in organizing empirical intuitions concerning claims problems, such ideas have remained largely unexamined in the theoretical literature.

Appendix A: Definitions of rules

In this appendix, we give formal definitions of the Talmud, Piniles', constrained egalitarian, random arrival, and minimal overlap rules.

The Talmud rule defines two regimes depending on whether the amount to divide is smaller or greater than the sum of the half-claims. If the amount available is smaller, then the Talmud rule coincides with the constrained equal awards rule applied to the vector of half-claims. If the amount available is greater than the sum of the half-claims, then the Talmud rule gives each individual her half-claim and uses the constrained equal losses rule to divide the remainder (with both claims and amount to divide truncated).

Talmud rule (*T*). *For all* $(c,E) \in \mathscr{C}$*, we have*

(i) *if* $E \leq \frac{1}{2}\sum_{i\in N} c_i$*, then* $T(c,E) = CEA(\frac{1}{2}c,E)$*; and*
(ii) *if* $E \geq \frac{1}{2}\sum_{i\in N} c_i$*, then* $T(c,E) = \frac{1}{2}c + CEL(\frac{1}{2}c, E - \frac{1}{2}\sum_{i\in N} c_i)$.

Piniles' rule and the constrained egalitarian rule coincide with the Talmud rule in the case where the amount to divide is smaller than the sum of the half-claims. Both rules use a more egalitarian procedure than the Talmud rule whenever the amount to divide exceeds the sum of the half-claims.

Piniles' rule (*Pin*). *For all* $(c,E) \in \mathscr{C}$*, we have*

(i) *if* $E \leq \frac{1}{2}\sum_{i\in N} c_i$*, then* $Pin(c,E) = CEA(\frac{1}{2}c,E)$*; and*
(ii) *if* $E \geq \frac{1}{2}\sum_{i\in N} c_i$*, then* $Pin(c,E) = \frac{1}{2}c + CEA(\frac{1}{2}c, E - \frac{1}{2}\sum_{i\in N} c_i)$.

Constrained egalitarian rule (*CE*). *For all* $(c,E) \in \mathscr{C}$*, we have*

(i) *if* $E \leq \frac{1}{2}\sum_{i\in N} c_i$*, then* $CE(c,E) = CEA(\frac{1}{2}c,E)$*; and*
(ii) *if* $E \geq \frac{1}{2}\sum_{i\in N} c_i$*, then, for all* $i \in N$*, we have* $CE_i(c,E) = \max\{\frac{c_i}{2}, \min\{c_i,\lambda\}\}$ *where* λ *solves* $\sum_{i\in N} \max\{\frac{c_i}{2}, \min\{c_i,\lambda\}\} = E$.

To define the random arrival rule, assume the individuals arrive one at a time and receive full compensations until the amount to divide runs out. The random arrival rule proposes as a division the average over all orders of arrival of the awards vectors obtained in this way. Let Π^N denote the class of all bijections that map N onto itself.

Random arrival rule (*RA*). *For all* $(c,E) \in \mathscr{C}$ *and all* $i \in N$*, we have*

$$RA_i(c,E) = \frac{1}{n!}\sum_{\pi\in\Pi^N} \min\Big\{c_i, \max\{E - \sum_{j\in N, \pi(j)<\pi(i)} c_j, 0\}\Big\}.$$

To provide a definition of the minimal overlap rule, we assume, without loss of generality, that the members of N are indexed such that $c_1 \leq c_2 \leq \cdots \leq c_n$. To understand the rule, each individual i has to be seen as claiming the part $[0, c_i]$ of the interval $[0, E]$. Two cases are distinguished. (i) In the case where there is an individual with a claim at least as great as the amount to divide, first all claims are truncated by the amount available. Then, each part of $[0, E]$ is divided equally among all individuals claiming it. For instance, the interval $[0, c_1]$ is claimed by everyone, so everyone gets c_1/n. The interval $(c_1, c_2]$ is claimed by everyone except individual 1, and so each member of $N \setminus \{1\}$ receives in addition $(c_2 - c_1)/(n-1)$. This process continues until the entire interval $[0, E]$ is covered. (ii) In the case where there is no individual with a claim at least as great as the amount to divide, one looks for a $t \in \mathbb{R}_+$ such that $(c_k - t) + (c_{k+1} - t) + \cdots + (c_n - t) = E - t$ where c_k is the smallest claim such that $c_k \geq t$. Each individual $i \in \{k, k+1, \ldots, n\}$ receives a share equal to $(c_i - t)$, i.e., the part of $(t, E]$ that i alone claims. The remaining part $[0, t]$ is divided as in case (i) with t as the amount to divide.

Minimal overlap rule (*MO*). *For all $(c, E) \in \mathscr{C}$, we have*

(i) *if $c_i \geq E$ for some $i \in N$, then, for all $i \in \{j \in N \mid c_j < E\}$, we have*

$$MO_i(c, E) = \frac{c_1}{n} + \frac{c_2 - c_1}{n-1} + \cdots + \frac{c_i - c_{i-1}}{n-(i-1)},$$

and, for all $i \in \{j \in N \mid c_j \geq E\}$, we have

$$MO_i(c, E) = \frac{c_1}{n} + \frac{c_2 - c_1}{n-1} + \cdots + \frac{c_{k-1} - c_{k-2}}{n-(k-2)} + \frac{E - c_{k-1}}{n-(k-1)},$$

where $k = \min\{j \in N \mid c_j \geq E\}$; and

(ii) *if $c_i < E$ for all $i \in N$, then, for all $i \in \{j \in N \mid c_j < t\}$, we have*

$$MO_i(c, E) = \frac{c_1}{n} + \frac{c_2 - c_1}{n-1} + \cdots + \frac{c_i - c_{i-1}}{n-(i-1)},$$

and, for all $i \in \{j \in N \mid c_j \geq t\}$, we have

$$MO_i(c, E) = \frac{c_1}{n} + \frac{c_2 - c_1}{n-1} + \cdots + \frac{c_{k-1} - c_{k-2}}{n-(k-2)} + \frac{t - c_{k-1}}{n-(k-1)} + c_i - t,$$

where t solves $\sum_{i \in \{j \in N \mid c_j \geq t\}} (c_i - t) = E - t$ and $k = \min\{j \in N \mid c_j \geq t\}$.

Appendix B: Description of categories

Over two questions, the response patterns belonging to the categories *same*, *decrease*, and *increase* can be defined using the proportional rule, the constrained equal awards rule, and the constrained equal losses rule as benchmarks.

1. *Same* progressivity in question x and question y:

   (a) Consistent with the constrained equal awards rule in question x and in question y.

   (b) Consistent with the proportional rule in question x and in question y.

   (c) Consistent with the constrained equal losses rule in question x and in question y.

2. *Decrease* of progressivity from question x to question y:

   (a) Consistent with the constrained equal awards rule in question x and less progressive than the constrained equal awards rule in question y.

   (b) More progressive than the proportional rule in question x and at most as progressive as the proportional rule in question y.

   (c) Consistent with the proportional rule in question x and less progressive than the proportional rule in question y.

   (d) Less progressive than the proportional rule but not consistent with the constrained equal losses rule in question x and consistent with the constrained equal losses rule in question y.

3. *Increase* of progressivity from question x to question y:

   (a) Consistent with the constrained equal losses rule in question x and more progressive than the constrained equal losses rule in question y.

   (b) Less progressive than the proportional rule in question x and at least as progressive as the proportional rule in question y.

   (c) Consistent with the proportional rule in question x and more progressive than the proportional rule in question y.

   (d) More progressive than the proportional rule but not consistent with the constrained equal awards rule in question x and consistent with the constrained equal awards rule in question y.

Over three questions, the five categories *same*, *decrease*, *increase*, *decrease-increase*, and *increase-decrease* are defined as follows.

1. *Same* progressivity over questions x, y, z: *Same* in x and y and *same* in y and z.

2. *Decrease* of progressivity over questions x, y, z:

   (a) *Decrease* from x to y and *decrease* from y to z.

   (b) *Decrease* from x to y and *same* from y to z.

   (c) *Same* from x to y and *decrease* from y to z.

3. *Increase* of progressivity over questions x, y, z:

   (a) *Increase* from x to y and *increase* from y to z.

   (b) *Increase* from x to y and *same* from y to z.

   (c) *Same* from x to y and *increase* from y to z.

4. *Decrease-increase* of progressivity over questions x, y, z: *Decrease* from x to y and *increase* from y to z.

5. *Increase-decrease* of progressivity over questions x, y, z: *Increase* from x to y and *decrease* from y to z.

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